

4.46, +0.82; Tennessee area, 2.47, -0.33; Arkansas, 3.67, +0.65; Mississippi area, 1.32, -1.42; Louisiana, 3.14, -0.81.

RIVERS.

Changes were generally slight in the upper Arkansas and low stages prevailed, except in Sedgwick County, where the Little Arkansas overflowed its banks on the 7th and put 2,000 telephones in Wichita, Kans., out of commission for several days and caused damage amounting to more than \$40,000. The lower Arkansas was at a navigable stage during the greater part of the month although no high stages occurred.

There were no floods in Oklahoma and all streams were low during the entire month.

Only slight changes occurred in the Red River and there was a slight but steady fall in the upper reaches of this river.

Two slight rises occurred in the upper White River, the first from the 7th to 13th, and the second between the 19th and 24th; otherwise stages were low. The lower White was at a stage of 27.5 feet, on the first 4 days of the month, but there was a steady fall after the 4th to a stage of 19.8 feet on the 30th.

Below St. Louis changes in the Mississippi River were slight, although a moderate rise commenced at St. Louis on the 14th and was general at the close of the month. No high stages were recorded.

NOTES.

Oklahoma (J. Pemberton Slaughter, section director).—Conditions were unfavorable for agricultural interests over the greater part of the State, except for the maturing and picking of cotton. The rainfall averaged nearly normal, but it was very irregularly distributed. The soil has been too dry for sowing winter wheat over large areas in the central and western counties.

Missouri (George Reeder, section director).—Weather conditions were generally favorable for outdoor work, except that harvesting and seeding were interfered with by local rains.

Tennessee (Roscoe Nunn, section director).—The rainfall was unevenly distributed. The mean temperature was the highest of record for September.

Arkansas (H. F. Alciatore, section director).—This was the hottest September of record. The rainfall was unevenly distributed. A small tornado occurred about 3 miles east-northeast of Ozark in Franklin County on September 4. It moved from the southwest. Very little damage resulted.

SEVERE LOCAL STORM,

By RICHARD H. SULLIVAN, Local Forecaster, Wichita, Kans.

A heat wave of several days' duration culminated on September 6, 1911, followed by threatening weather in the southwest about 4 p. m. The first thunder peal was heard at 4.28 p. m., and a sprinkle began at 4.30 p. m. Precipitation was heavier at 5 p. m., when hail began falling with rain. The rain and hail continued with varying intensity until 6.10 p. m., when the hail ended and the rain continued, finally ending at 7.50 p. m.

Four distinct storm clouds, passing at intervals of about 15 minutes each, dropped hail of four different kinds, ranging in size from large peas and small marbles to large hen's eggs. The kinds and sizes were as follows: Solid snow, ice-coated, 0.25 to 1 inch in diameter; gnarled ice, 0.5 by 1 by 2 inches; solid ice, round, 0.75 to 1 inch in

diameter; alternate layers of ice and snow, some nearly round, some oval and some crescent shaped, the largest of which was 3 inches in diameter, 2.5 inches thick and 9.25 inches in circumference. Except in the weight of the larger stones, the hail was not heavy at any time. The stones came straight down mostly between the wind squalls of 25 to 42 miles per hour which prevailed at intervals as the storm clouds passed.

Excessive precipitation was recorded after 5.12 p. m., 0.73 inch being registered in 47 minutes. The hail, if placed on a level, approximated 0.2 inch in depth, and the estimated amount of water is 0.15 inch.

About 6 p. m., another thunderstorm developed a few miles west of the city and moved northeastward, with vivid lightning and heavy thunder. The storms finally massed in the northeast, and the last thunder was heard at 7.45 p. m.

Practically all the greenhouse roofs in the city were ruined, and thousand of skylights in the business districts and the northside windows in the residence sections were demolished, entailing a loss estimated at \$40,000.

During the progress of this series of storms the sky was visible in the northwestern and southeastern horizons nearly all the time. Reports from persons south of the city and from travelers coming from the north on the Interurban Railway show that the path of the general storm was about 7 miles wide, running irregularly from the southwest to the northeast.

About 9 p. m., on the 6th, another thunderstorm of marked intensity, with a brilliant display of lighting and extremely heavy thunder, began moving southeastward over the city. First thunder peal heard, 9.08 p. m. Light rain began at 9.25 p. m., precipitation becoming excessive at 10.06 p. m., 1.10 inches falling in 37 minutes. A heavy squall of 45 miles per hour from the northwest occurred at 9.39 p. m., followed by comparatively light winds about 10 p. m., and a gale of 47 miles from the west at 10.27 p. m.

There was a continuous roar of thunder from all parts of the heavens from 10 p. m. of the 6th to about 5.30 a. m. of the 7th. An unprecedentedly excessive rainfall began at 11.37 p. m. of the 6th and continued to 2.59 a. m. of the 7th, and an extraordinary total amount of 7.16 inches was measured for the period, 9.34 p. m. of the 6th to 6.26 a. m. of the 7th. The total amount for the 24 hours was 7.99 inches, the actual time during which rain fell being 10 hours and 36 minutes. This amount exceeds the previous highest 24-hour record on November 12-13, 1909, by 3.25 inches.

Other excessive amounts were recorded as follows: Greatest during any 5 minutes, 0.66; 10 minutes, 0.87; 15 minutes, 0.98; 30 minutes, 1.26; 1 hour, 1.86; 2 hours, 3.54.

Subsequent reports from neighboring towns and cities indicate that the heavy rains were confined to a radius of about 25 miles north and south of Wichita and 50 miles east and west.

The heavy rains in Wichita and to the northward of the city caused a rapid rise in the drainage canal in the old Chisholm Creek Basin in the eastern part of the city, and by the morning of the 7th there was a flood in the canal zone averaging about 1,600 yards wide. At Thirteenth Street and the canal bridge the water was 2.5 feet deep; at the Douglas Avenue bridge the water was 1.5 feet deep. Many houses built on low foundations in the drainage area were flooded to depths of 1 to 3 feet. The Arkansas River running through the western part of the city showed a rise of 1.8 feet to -3.6 feet on the gauge by 7 a. m., and the water continued at this stage until

after 6 p. m. The flood waters in the canal began receding during the late afternoon, and by the following morning the flow had subsided to within 2 feet of the top of the banks.

The weakened condition of roofs and the breakage of thousands of windows and skylights, due to the rain, hail, and high winds of the afternoon of the 6th, together with the extraordinary downpour of rain, with wind squalls, during the following night, caused a general loss, including that of the greenhouses, estimated at \$190,000.

THE DROUGHT AND HOT WEATHER OF 1911, IN KANSAS.

By S. D. FLORA, Observer, Weather Bureau.

The crop-growing season of 1911, extending from March to September, inclusive, has averaged the warmest and, with two exceptions, the driest that has been experienced in Kansas since the State weather service was established in 1887.

At practically all the stations in central and northeastern Kansas the maximum temperatures of the summer of 1911 were the highest on record and the maximum of 116° at Hugoton and Clay Center on June 25, 1911, is the highest temperature ever recorded in the State by a reliable thermometer properly exposed to the free air. The previous high temperature record in the State is 115° at Manhattan on July 9, 1860.

The average daily departure from the normal temperature for the State was +3.0°. The nearest approach to this in the past 25 years was +2.2° in 1887. The summer of 1910 was the third warmest in this period, averaging 1.9° above the normal.

The drought that prevailed during the crop season of 1911 was really a continuation of the general deficiency

in precipitation which began in 1910. The latter year was the fourth driest in 25 years, taking the average of the State as a whole, and the precipitation was below the normal in all parts of the State, except in a few counties in the lower Kansas Valley. In some south-central and northwestern counties less than half the normal amount of precipitation was received that year. This general drought was relieved by the wettest February on record in the State.

The deficiency in precipitation from March 1 to September 30, 1911, has been surpassed by that of but 2 previous crop-growing seasons—those of 1890 and 1894. The average precipitation for the State for these 7 months was 16.76 inches, 72 per cent of the normal amount. The State average for 1890 was 15.10 inches and for 1894 it was 16.33 inches. The deficiency in precipitation during 1911 prevailed in all parts of the State, excepting five widely scattered counties. In some of the western counties less than half the normal amount of precipitation fell from March 1 to September 30. The station reporting the least precipitation was Lakin in the Arkansas Valley in the second tier of counties from the Colorado line. This station received but 4.76 inches during the 7 months.

In the southeastern quarter of the State, where the drought of 1910 was most severe, from 17 to 33 inches of rain fell during the crop-growing season of 1911.

Only a comparatively few stations have records available for comparing the drought of 1911 with other dry seasons that have occurred in the State previous to 1887, but these clearly indicate that drier weather prevailed in northeastern and central Kansas during the summers of 1843, 1860, 1864, and 1874, though at Wallace, in extreme western Kansas, no drier summer has occurred since weather records were begun there in 1870.